REMARKS

Reconsideration of the application is respectfully requested for the following reasons:

1. Objection to Claims 22-25 Under 37 CFR 1.75(c)

This objection has been addressed by amending claims 22-25 to delete the multiple dependency of claim 19, from which claim 22 depends. As a result, multiple dependent claim 22 no longer depends from a multiple dependent claim.

2. Rejection of Claims 5-8, 10-13, 20, and 20 Under 35 USC §112, 1st Paragraph

This rejection is on the grounds that the Examiner does not understand various phrases included in the claims (even though virtually identical phrases were understood and accepted by the Examiner in U.S. Patent No. 6,344,909, of record in the present application).

Reconsideration and withdrawal of the rejection is respectfully requested for the following reasons:

a. "Transformation" Recited in Claims 5 and 17

Claim 5 was rejected on the grounds that the nature of the nature of the "transformation" is not described, and on the grounds that a real function cannot be "transformed" into a complex function.

In reply, the Applicant respectfully submits that the Examiner has read too much into the claim language, *i.e.*, that the Examiner has improperly read the claim language as requiring some sort of specific "transform" such as the Fourier, Walsh, *etc.* transforms specified in claim 7, rather than a more general "transformation" or "conversion." The word "transform" as used in claim 5 (and 17) was simply intended to refer to the application of the "diffuser" to the image (which has the effect of averaging amplitude values), and the subsequent representation of the resulting pixel amplitudes and phases in complex form (a common way to represent harmonic functions).

To avoid confusion as to meaning of "transformation," claims 5 and 17 have been amended to clarify that the "transformation" involves a change in the way that the pixels are represented rather than a specific mathematical transform, and in particular that the "transformation" involves associating phases of a diffuser with pixels of the transformed two-dimensional image and representing the result of the association as a complex number defined by a calculated amplitude and phase value for the diffused two-dimensional image. Support for this amendment is found in lines 9-19 on page 12 of the original specification.

The Examiner will appreciate that it is conventional to representing pixels of a holographic image in the form $g(Y,Z)=U_0e^{i(\mathbf{k}\cdot\mathbf{r}-\omega t)}$, where U_0 is the amplitude of the pixel and $\mathbf{k}\cdot\mathbf{r}-\omega t$ is the phase. In this case, $\mathbf{k}\cdot\mathbf{r}-\omega t$ is a pseudorandom number, *i.e.*, rand(Y,Z), because the phase of the diffuser is defined, as described in line 12 on page 12, as being pseudorandom, and the amplitude value can be represented by the square root of the real part of the complex function, *i.e.*, $(f(Y,Z)^{1/2})$. Claims 5 and 17 simply refer to this type of "transformation," *i.e.*, the representation of optical wave functions for image pixels in complex form to simplify calculations, as described in lines 9-19 on page 12 of the original specification, and therefore meets the requirements of 35 USC §112, 1st Paragraph.

b. Convolutional Product and "Components" Recited in Claim 8

Claim 8 was rejected on the grounds that the Examiner believes that the components of the convolutional product are not sufficiently narrowly defined, and on the ground that "convolutional product" is not accurate.

In reply, the "components" whose convolutional product are computed have been more clearly recited as the function which describe the optical wave and the function which describes the oversampled complex image, and the somewhat colloquial phrase "convolutional product" has been replaced by "convolution." It is believed that since the optical wave and the oversampled complex image each has a well-defined function, and since the convolution of the

functions (as defined in item 9 of the Official Action) is also well-defined, claim 8 is now definite.

As with claim 5, it is respectfully noted that the a corresponding recitation of a convolutional product of two components was found to be acceptable in U.S. Patent No. 6,344,909.

In addition, it is respectfully noted that a corresponding change has been made to claim 20.

c. Meaning of Amplitude Value, Corresponding Value, and Point of the Image

This ground for rejection is believed to be overcome by the amendments to claim 17, which are similar to those discussed above with respect to claim 5, and by deleting the term "value" after "amplitude" and "phase," and by referring to pixels rather than points. It is entirely conventional to represent an amplitude as the square root of a real function *f* defining a pixel of a holographic the image, and to associate a phase therewith, as indicated above, which is all that is recited in claims 6 and 18.

3. Rejection of Claims 1-25 Under 35 USC §112, 2nd Paragraph

This rejection is again respectfully traversed on the grounds that while the subject matter of the application is admittedly complex, complexity or difficulty understanding the subject matter of the claims is not a proper grounds for rejection. It is respectfully submitted that the claims use standard terminology well-understood by those skilled in the art, are written in proper U.S. format, and are not a literal translation from a foreign document. Evidence of the propriety of the claim language is found in U.S. Patent No. 6,344,909, which while directed to a distinct invention, nevertheless shares elements of the presently claimed invention which were worded in the same manner as the present claims, and which the Examiner in that case had no difficulty understanding.

Nevertheless, certain changes have been made to the claim language in the hope that the invention will be more easily understood by the Examiner. In particular, as mentioned above, the "two components" language has been deleted from claims 8 and 20 in favor of an equivalent, but more direct, recitation that the convolution is applied to functions describing the optical wave and oversampled complex image. Moreover, instead of reciting that the complex image diffracts an optical wave, claim 5 now recites that what is simulated is diffraction of optical waves by an image having optical properties of an image represented by the oversampled complex image.

If the Examiner prefers alternative language, the Examiner is invited to contact the undersigned at any time to discuss such alternative language.

4. Rejection of Claims 1-4 and 14-16 Under 35 USC §102(b) in view of U.S. Patent No. 4,969,700 (Haines)

This rejection is again respectfully traversed on the grounds that the Haines patent fails to disclose or suggest a method or system of producing a hologram of a virtual object, as recited in claims 1-4 and 14-16, which involves the step of computing a set of two-dimensional images representing "the object" (*i.e.*, the entire object) as seen from respective different viewpoints in three-dimensional geometrical space, and computing elementary holograms based thereon. The alleged "two-dimensional" images of Haines result from the use of "windows" 200 or 400 that restrict the field of view of the object to parts of the object, rather than the entire object.

In reply to this argument, the Examiner alleges that Haines teaches that associated with each element hologram (52 and 54) is a view of the object and that the view consists of light rays from **all parts of the object, that is to say a full view of the entire object is represented at each element hologram** (citing col. 5, lines 1-6). However, this teaching of Haines is a general statement concerning computer generated holograms, and not a teaching of the claimed computation of a set of two-dimensional image representing the entire object as seen from respective different viewpoints in three-dimensional geometrical space. In other words, the Examiner has taken this teaching of Haines out of context. **The specific method disclosed by**

Haines for computing two-dimensional images clearly requires limitation of a field-of-view, as argued in the previous response.

According to the invention, a set of two-dimensional images representing the object as seen from different perspective viewpoints is computed (steps E1-E4). Then, a set of elementary holograms, each corresponding to one of the two-dimensional images, is computed (steps E5-E6). Finally, a hologram of the object is formed by combining the elementary holograms (step E7). **In other words, the claimed invention involves creating a *set* of two-dimensional images of the object from different viewpoints, creating a *set* of holograms from the images, and then combining the holograms two create a hologram of the object.** Nothing in the Haines patent suggests these steps. The passage in Haines cited by the Examiner merely points out that each element hologram consists of light waves from each part of the object (which is essentially the definition of a hologram). Haines does not suggest the creation of the claimed two-dimensional images representing different views of the entire object, creation of holograms therefrom, and only then combining the holograms in the manner claimed.

Instead, Haines specifically teaches, in col. 5, lines 34-37, that his invention systematically selects "***only rays from a limited number of points in the object for use.***" Furthermore, in col. 6, line 36, Haines continues that "***the amplitude of the selected rays [...] are determined by the computer across a surface [...]. The rays from the object that are selected [...] are those that are on a straight line between the hologram grid element and its associated window.***" As mentioned in the previous response, Haines specifically states that the windows in question (windows 200 and 400), limit the field of view of each hologram element 52,54 such **that each hologram element sees a restricted field of view of the object through the window** (as explained in col. 6, lines 45-51 and lines 59-61).

In the summary section of Haines' specification, col. 1, line 60 to col. 2, line 52, Haines very generally discloses the partitioning of the holographic surface into a grid, so as to obtain grid elements, as follows: "*The contribution of light from the object to each grid element is*

envisioned as a bundle of light rays emanating from each part of the object and converging onto each grid element. The amplitude of each ray of light arriving at a given grid element is determined [...]." **The determination of the amplitude of each ray of light arriving at a given grid element does not involve any sort of surface or window and cannot reasonably be considered to the claimed two-dimensional image representing a projection of the object into a specific plane, corresponding to steps E1-E4 of the claimed method.**

In other words, the passage quoted by the Examiner, which refers to Figs. 1 and 2, does not illustrate the claimed two-dimensional images. Instead, Figs. 1 and 2 are merely intended to be illustrative of the concepts of conventional and "image-plane" holograms, to be synthesized in a computer as a combination of element grid elements. The statement quoted by the Examiner to the effect that "*the view consists of light rays of all parts of the object*" is for the purpose of introducing the concept of computer-based holograms in general, and not a teaching of the claimed two-dimensional images. This is made clear in col. 3, lines 67 *et seq.* of Haines, which point out that "*figs. 1 and 2 are illustrations of two different positionings of a holographic surface relative to an object in order to introduce the concepts of the present invention.*" On the other hand, when Haines actually does teach the creation of image elements, Haines specifically requires limitation of the field of view, contrary to the presently claimed invention.

The effect of the windows is illustrated in Exhibit I, attached hereto. Exhibit I includes a copy of original Fig. 4 showing the effect of the "windows" of Haines. In practice, the embodiment disclosed by Haines does not provide images of the *entire* object, as claimed, and therefore the Haines patent cannot anticipate the claimed invention, and withdrawal of the rejection of claims 1-4 and 14-16 under 35 USC §102(b) is respectfully requested.

5. Rejection of Claims 5-13 and 17-25 Under 35 USC §103(a) in view of U.S. Patent Nos. 4,969,700 (Haines) and 5,668,648 (Saito), and the SPIE article by Michelin *et al.*

This rejection is again respectfully traversed on the grounds that the Saito patent and the Michelin article, like the Haines patent, fails to disclose or suggest any steps or means

corresponding to the claimed computation of (i) two-dimensional images representing the object as seen from different viewpoints in three-dimensional space and (ii) elementary holograms each corresponding to one of the two-dimensional images, the final hologram being formed by a combination of the elementary holograms computed from the two-dimensional images representing the object as seen from different viewpoints in three-dimensional space.

Instead, the Saito patent is directed generally to use of Fourier transforms to generate diffraction elements similar to those that make up the hologram of Haines, while the Michelin article teaches generally how to use Fourier transformations to compute amplitude transmittance from complex fields representing the reference wave. Neither reference is directed to construction of a hologram from two-dimensional images, much less two-dimensional images that represent the entire object in the manner claimed.

Accordingly, withdrawal of the rejection under 35 USC §103(a) in view of the combination of Haines, Saito, and Michelin, is respectfully requested.

6. Double Patenting Rejection

This rejection is respectfully traversed on the grounds that since the Haines patent does not disclose or suggest the claimed set of two-dimensional image data representing the entire object as seen from different viewpoints in three-dimensional geometric space, or a system or method in which the different viewpoint holograms are used to compute a set of elementary holograms from which the final hologram is constructed, the claimed invention does not represent an obvious modification of the calculation process recited in Applicant's U.S. Patent No. 6,344,090.

Withdrawal of the obviousness double patenting rejection is therefore respectfully requested.

Serial Number 09/530,968

Having thus overcome each of the rejections made in the Official Action, withdrawal of the rejections and expedited passage of the application to issue is requested.

Respectfully submitted,

BACON & THOMAS, PLLC

Date: November 30, 2004 By: BENJAMIN E. URCIA
Registration No. 33,805

BACON & THOMAS, PLLC
625 Slaters Lane, 4th Floor
Alexandria, Virginia 22314

Telephone: (703) 683-0500